

The State's Responsibility in Oil and Brine Pollution Originating in Oil Fields

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THE STATE'S RESPONSIBILITY IN OIL AND BRINE POLLUTION ORIGINATING IN OIL FIELDS

The subject as indicated in the title of this article has to do with the state's attitude and responsibility in matters pertaining to oil and brine pollution originating in the Kansas oil fields. The following remarks will be confined to state control of oil pollution as it exists in Kansas. Several other states are no doubt confronted with the same problems but in order to save possible confusion the regulations of other states will not be included in this paper.

A brief resume of the statutes pertaining to the Kansas State Board of Health may clarify the work of that organization as to its present duties as related to control of oil field pollution.

The law of 1885 gave the State Board of Health certain functions and powers. A section now known as 65-103 revised statutes of 1923, made provision for special sanitary service. This section gave the Board authority to appoint or employ committees or persons to render special sanitary service, and to make or supervise practical or scientific investigations.

Under authority of this section, the Board some time later appointed the Dean of the Engineering School at the University of Kansas as a consultant to the Board. When it became evident that more definite authority would be required by the Board for more adequate control in problems of public water supply and stream pollution, the law known as "The Water and Sewage Law" was passed. This came about in 1907, with certain modifications added in 1909. This statute is now known as 65- (161-171), Revised Statutes 1923.

This law authorized the Board to establish certain rules and regulations controlling the quality of water furnished for domestic use and gave authority to prescribe how sewage wastes were to be treated before being discharged into the surface waters of the state.

Eight years later after a state water survey, undertaken jointly by the University and the United States Geological Survey, had shown the need of more laboratory data for the proper control of public water supplies, a law was enacted establishing

the state water laboratory on a fee-supported basis and located at the University of Kansas.

The original water and sewage law gave the Board broad authority to control stream pollution when it was found that pollution was occurring that was considered by the Board as prejudicial to the health of any of the inhabitants of the state. This authority was greatly increased by an amendment to the law (Chapter 239 Sessions Laws of 1927) which gave the Board authority to control stream pollution, not only from the standpoint of public health, but also wherever the Board found that the surface waters of the state were being polluted from an abatable source in a manner detrimental to the animal and aquatic life of the state.

Due to the fact that the University was an early cooperating agency with the Board, it logically followed that the work of this division should continue to be associated with the Departments of Chemistry and Bacteriology and with the School of Engineering. While the laboratory was originally organized separately from the Sanitary Engineering Service, their inter-relationship made it desirable to more closely coordinate the work, and in 1920 both services were placed under one director, and in 1923, the laboratory and sanitary engineering offices were combined and located in the basement of the Engineering Building at the University. The University has been generous in supplying adequate space for this basic state service agency.

In December, 1929, by authority of the Board and with the approval of the University, the name of Division of Sanitation was applied to the state service work of the University, formerly known as the Water and Sewage Laboratory, and the Sanitary Engineering Service. The accomplishments of the State Board of Health can be regarded with a just pride because of its pioneering attitude in matters pertaining to health and to food and drug legislation.

Early established rules and regulations of the Board, prescribe for this Division the primary responsibility of supervising all public water supplies, both by regular inspection and by laboratory analysis. By this supervision, the Board expects to eliminate any possible chance of a public water supply becoming the source of a water borne disease. The epidemiological record

of the past 15 years is evidence that this result has been and is being accomplished.

The Division of Sanitation of the State Board of Health is located at the University of Kansas and consists of the State Water and Sewage Laboratory and the Sanitary Engineering Service. The Laboratory is supported by fees collected for the analysis of water under authority of Section 65-156-157, R.S. 1932. The Sanitary Engineering Service is supported, so far as salaries are concerned, as a part of the State Service Work of the University. Field expenses are paid from the special sanitary fund of the State Board of Health. The sanitary engineering field work provides for the required investigation of all public water supplies, bottled water supplies, source of railroad water, municipal sewage treatment plants and special investigational work of stream pollution from the standpoint of public health. These investigations and inspections are authorized by Section 65-159 to 65-171, inclusive general statutes 1935. The Oil Field Section as set up in the Division of Sanitation, functions under the authority granted in the above statutes. The particular work of the above section has to do with problems pertaining to oil field brines, oil field waste disposal and abatable pollution originating in oil field operations.

GENERAL RULES AND REGULATIONS OF THE STATE BOARD OF HEALTH

OIL FIELD WASTE DISPOSAL REVISED 1939

ADOPTED UNDER AUTHORITY OF CHAPTER 65-164-169 INCLUSIVE
AND CHAPTER 65-171a-171f INCLUSIVE, GENERAL STATUTES 1935

RULE 1. It shall be the duty of the Division of Sanitation of the State Board of Health to conduct investigations and field surveys to determine the source and amount of all oil field wastes, including mineralized and otherwise modified waters produced with petroleum in Kansas; to investigate methods for the disposal of such wastes; and to make recommendations for this disposal in such manner as to prevent or reduce, insofar as possible, the pollution of the natural fresh water resources of the State. Recommended methods for the disposal of oil field wastes shall show the location of the project and shall be submitted to the

corporations, companies, or individuals responsible for the production of the industrial waste, to the State Forestry, Fish and Game Department, and to the State Corporation Commission. Upon receipt of the report giving the method recommended for the disposal of oil field wastes, the corporation, company, or individual responsible for the production of the industrial waste shall within thirty days file with the State Board of Health a statement either accepting the method as recommended or requesting a hearing. Upon request for a hearing, or upon its own motion, the State Board of Health will designate, through its executive secretary, a time and place for a hearing for all parties interested in the project. Following the hearing, the State Board of Health will, at a regular meeting, issue such order as may in its judgment be necessary to prevent abatable pollution of the fresh water resources of the State from sources of pollution covered in the project under consideration. Appeals from the order of the State Board of Health may be taken under authority of Section 65-164, G.S. 1935.

RULE 2. It is further ordered by the State Board of Health, subject to the approval of the Attorney General and the State Board of Regents and in compliance with the provision of Section 65-171d, G.S. 1935, that in order to cover the cost of services rendered under the rules and regulations of the State Board of Health, as adopted under authority of Section 65-171d, 65-171f, inclusive, pertaining to the prevention of stream pollution originating from waste incident to the production of petroleum in the State of Kansas detrimental to the public health and to the animal and aquatic life of the state, there should be an assessment at a uniform rate per barrel made against all petroleum produced in the state. This assessment shall only apply to the first purchase of the oil from the producer, and not to subsequent transfers commonly referred to as "Tenderships."

The first purchaser of the production, who is hereby defined to be the person holding the Division Order and issuing checks to pay for the working interest or royalty interest, or both, shall before issuing checks or otherwise accounting for the production, deduct one-twenty-fifth of one cent per barrel for each barrel of oil produced and removed from the lease each month and shall remit the amounts so deducted to the Division of Sanitation, State Board of Health, Lawrence, Kansas at the same time

and periods as said purchasers make their regular crude oil payments.

Said remittances may be sent in a single check each month, if the purchaser so desires, and the purchaser shall not be required to render further accounting other than to show the deductions under this order on the regular payment statements to producers and royalty owners, or other parties interested. The charge and assessment herein provided for shall be effective in connection with the remittance covering the producing of oil in the month of July, 1939.

RULE 3. The State Board of Health retains authority to make such changes in the above rules and to issue such additional regulations as may be necessary to secure effective prevention of abatable pollution of water resources of the state, subject to approval as provided for in Section 65-171d, G.S. 1935.

Revised Rules and Regulations, effective July 1, 1939.

Approved: June 27, 1939

F. P. HELM, M.D., *Sec.*
Kansas State Board of Health.

Approved: June 20, 1939

JAY S. PARKER
Attorney General, State of Kansas

Approved: June 17, 1939

GUY D. JOSSERAND, *Director*
Kansas Forestry, Fish and Game Commission

Approved: June 24, 1939

HUBERT BRIGHTON, *Sec.*
Kansas State Board of Regents

Published in official state paper, June 29, 1939.

The problem of oil field brine disposal reached a climax a few years prior to 1935. Litigation pertaining to pollution of fresh water was taking a heavy toll from the oil operators. Courts were granting heavy damages penalties against the operator found guilty in the careless handling of brines. Fortunately the state's legislature took a hand in further safeguarding the water supplies by the passage of two acts in 1935, one allowing the return of oil field brines into sub surface formations and the act

which allows the repressuring or water flood of oil properties. (Ch. 55-133 and Ch. 55-901 R.S. 1935). The rules and regulations concerning these two legislative measures are promulgated by the State Corporation Commission. The oil industry welcomed these measures, the one in particular, as a means of eliminating much of the salt water disposal hazard. These two acts and related statutes are given as they appear in the Revised Statutes of 1935.

55-118. SALT WATER OR MINERALS TO BE EXCLUDED BY CASING AND PLUGGING. If any well or other excavation be put down to or through any vein or strata containing salt water or water containing any minerals in appreciable quantities, it shall be the duty of the owner or operator, driller or person putting down such well or excavation to case or plug such well or excavation in such manner as to exclude all salt water or water containing minerals in appreciable quantities from both upper and lower veins or strata holding water suitable for domestic purposes. (L.1919, ch. 233, paragraph 1: March 4; R.S. 1923, paragraph 55-118).

Cross reference: Disposal of salt water, see paragraph 55-901, 55-902.

Proof of negligence not necessary for recovery hereunder. Martin V. Shell Petroleum Corp., 133 K. 124, 128, 299 P. 261.

55-119. SAME: INJUNCTION. All persons, companies or corporations, private or municipal, owning or controlling a supply of water for domestic purposes, injured or threatened with injury by a violation of the provisions of section 1 (55-118) of this act, shall be entitled to a remedy by injunction, mandatory or prohibitive, in any court of competent jurisdiction against any person, company or corporation causing or threatening to cause such injury. (L. 1919, ch. 233, paragraph 2; March 4; R.S. 1923, paragraph 55-119).

55-120. SAME: PENALTY. Any violation of section 1 (55-118) of this act shall be a misdemeanor, punishable by fine of not more than \$1,000. Prosecutions under this act must be begun within six months after the commission of the offense. (L. 1919, ch. 233, paragraph 3; March 4; R.S. 1923, paragraph 55-120).

55-121. SALT WATER, OIL OR REFUSE FROM WELLS; PREVENTION OF ESCAPE. It shall be unlawful for any person, having possession or control of any well drilled, or being drilled for oil or gas, either as contractor, owner, lessee, agent or manager, or in any other capacity, to permit salt water, oil or refuse from any such well, to escape upon the ground and flow away from the immediate vicinity of such well, and it shall be the duty of any such person to keep such salt water, oil or refuse safely confined in tanks, pipe lines or ponds, so as to prevent the escape thereof: PROVIDED, HOWEVER, That this act shall not be construed to apply to the escape of salt water, oil or refuse because of circumstances beyond the control of the person in the possession or control of such well and under circumstances which could not have been reasonably anticipated and guarded against. (L. 1921. ch. 198, paragraph 1; March 10; R.S. 1923, paragraph 55-121).

Source of prior law: L. 1917, ch. 246, paragraph 1.

Cross reference: Disposal of salt water, see paragraph 55-901 to 55-902.

Sufficiency of evidence to show connection between plugged gas well and pollution of water well. *Hall v. Galey*, 126 K. 699,702, 271 P. 319.

Indefinite clause should be construed with whole context; not unconstitutional. *State v. Lebow*, 128 K. 715, 716, 280 P. 773.

Section construed in action for damages to cattle from stream pollution. *Manhattan Oil Co. v. Mosby*, 72 F. 2d 840, 842, 847.

Oil company held liable for damages caused by escaping salt water. *Berry v. Shell Petroleum Co.*, 140 K. 94, 101, 33 P. 2d 953.

Escape of oil held "legal cause" of damage to bridge. *State Highway Comm. v. Empire Oil & Ref. Co.*, 141 K. 161, 163, 40 P. 2d 355.

55-122. PENALTY FOR VIOLATION paragraph 55-121. Any person knowingly or willfully violating any of the provisions of the preceding section shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not exceeding one thousand dollars, or by imprisonment not exceeding one year, or by both such fine and imprisonment, and each day any such violation continues shall be deemed a separate offense. (L. 1921, ch. 198, paragraph 2; March 10; R.S. 1923, paragraph 55-122).

REPRESSURING AND WATER FLOODING

Cross reference: Device to increase flow, see paragraph 55-113.

55-133. Injection of air, gas, water or fluids upon oil and gas properties; application required. The owner or operator of any well, or wells, which produces oil or gas from any sand, strata, or formation, shall be permitted, in the interest of oil and gas conservation, to introduce and inject air, gas, water, or other fluid under pressure upon such sand, strata, or formation, for the purpose of recovering the oil and gas contained therein:

PROVIDED, that the owner or operator of a well into which water or other fluid is to be introduced into the sand, strata, or formation, shall make a written application to the state corporation commission for authority so to do, and written approval has been granted him by the state corporation commission: And provided further, That the operation shall be done under the rules and regulations of the commission. (L. 1935, ch. 212, paragraph 1; March 19).

55-134. RULES AND REGULATIONS AUTHORIZED. The state corporation commission is hereby directed to prescribe such rules and regulations as are necessary to carry out the provisions of this act. (L. 1935, ch. 212, paragraph 2; March 19).

55-135. ASSESSMENT OF COST. The state corporation commission is hereby directed to assess any cost that may be incurred under the provision of this act against all interested parties in such proportion as may be just and equitable. (L. 1935, ch. 212, paragraph 3; March 19).

ARTICLE 9.—SALT WATER

Cross reference: Salt water and minerals, see par 55-118 to 55-122.

55-901. DISPOSAL OF SALT WATER: REGULATIONS. That the owner or operator of any oil or gas well which may be producing and which produces salt water or waters containing minerals in an appreciable degree, shall have the right to return said waters to any horizon from which such salt waters may have

been produced, or to any other horizon which contains or had previously produced salt water or waters containing minerals in an appreciable degree: PROVIDED, That the owner or operator of such well makes a written application to the state corporation commission for authority so to do, and written approval has been granted him after investigation by the state corporation commission: AND PROVIDED FURTHER, That the state corporation commission is hereby directed to prescribe such rules and regulations as may be just and equitable to so carry out the provisions of this act (L. 1935, ch. 211, paragraph 1: March 19).

55-902. PENALTY FOR VIOLATIONS. Any person, owner, or operator violating any of the provisions of this act shall, upon conviction thereof, be deemed guilty of a misdemeanor, and shall be fined in the sum of not more than \$500, or by imprisonment in the county jail of not more than six (6) months, or be subject to both fine and imprisonment. (L. 1935, ch. 211, paragraph 2: March 19).

OIL-FIELD SECTION

The general program of the Oil-Field section can be summarized as follows:

1. Checking complaints
2. Inspections of brine and oil waste disposal methods
3. Special field surveys and studies
4. Major stream pollution cases
5. Casing programs for disposal wells
6. Furthering community disposal well projects
7. Water flood projects
8. Bottom hole cementing
9. Recommendations to abandon small oil producers which have an excessive oil water ratio
10. State service work
11. Educational program

CHECKING COMPLAINTS

Complaints pertaining to pollution originating in oil fields reach this section from the following sources: Landowners, Attorney General's office, Forestry, Fish, and Game Commission, Division of Water Resources of the State Department of Agriculture, Corporation Commission and the Governor's office. The improper and oftentimes heedless handling of oil field brines and oil spills accounts for the majority of the complaints. If correspondence with the offending parties fails to clear the complaint, a field inspection and follow up usually brings the desired result. The majority of the operators are quite cooperative and will

rectify the trouble when it is pointed out to them along with our recommendations.

INSPECTIONS OF BRINE AND OIL WASTE DISPOSAL METHODS

It is gratifying to note that in practically all of the new oil areas the cost of brine disposal is being carried along with operating costs by most of the major companies. The following of such a policy protects the operator from much of the usual litigation pertaining to pollution of fresh water horizons which in many instances follows in a development where but little thought has been given to adequate disposal. Chloride analysis of fresh water wells before development occurs, and making the analysis a matter of record, is an excellent practice for the operator to follow.

The field staff makes it a point to inspect all disposal methods employed and to work with the operators in matters pertaining to the improvement of those methods. Disposal into deep geological formations is looked upon at this time as the most logical means of brine disposal. The theory that evaporation will take care of the brine in earthen storage has been discarded. Water vapor alone is taken up by evaporation which results in a more concentrated brine.

SPECIAL FIELD STUDIES

Burrton Pool Area. One of the major studies carried on during the past two years was the detailed survey of the Burrton oil pool located in the Equus bed area in Reno and Harvey Counties. Located in this area is one of the state's most valuable fresh water aquifers. The recently completed water supply project for the City of Wichita is also in this area. Unfortunately the Burrton oil pool is also in the same general area some 8 to 10 miles up the drainage. Not only is the oil pool higher on the surface drainage but higher on the sub-surface drainage. It is evident, therefore, that the salt water produced with the oil and placed in earthen storage would infiltrate downward to the shallow fresh water and contaminate it. For that reason the State Board of Health passed a resolution "Pertaining to the Disposal of Oil Field Brines in the Equus Bed Area in Kansas," which appears below:

WHEREAS, under authority of Sections 65-164-169 inclusive and 65-171a-171f inclusive, G.S. 1935, and in compliance with the general rules and regu-

lations adopted to direct its action taken under authority of the above statutes, the Kansas State Board of Health did, on March 24, 1937, adopt a resolution reading in part as follows:

"Be it further resolved, that within the Equus Bed area the State Board of Health recognizes and formally approves the disposal of oil well brines by return to deep geological formations through disposal wells or for use in repressuring, when approved by the State Corporation Commission.

"Be it further resolved, that methods of brine disposal being used in this area other than the methods above approved are not regarded as adequate for the protection of the fresh water resources of the Equus Bed Area," and

WHEREAS, recent surveys of the oil fields located in the general area known as the Equus Beds show that oil field brines are still being disposed of in such a manner as to jeopardize the quality of the valuable fresh water resources of this area, in that brines are being placed in earthen tanks and ponds for temporary or permanent storage, and that these structures do not confine the brines placed in them but permit seepage, and

WHEREAS, it has been amply demonstrated that there exists in the area deep seated geological formations suitable for disposal use.

THEREFORE, BE IT RESOLVED that the Kansas State Board of Health does hereby formally condemn and prohibit the use of earthen storage for oil field brines in the Equus Bed area in such manner as to allow or permit the seepage or escape of salt water into the freshwater formations or into the streams or rivers of the state,

BE IT FURTHER RESOLVED that all oil producers in this area be notified of this action taken this 22nd day of November, 1939, by the State Board of Health assembled in special meeting.

Two assistant engineers with this department, were engaged in the actual field of work in the Burrton area. A portion of the work consisted in the sinking of auger test holes located below salt water ponds and carried down to the first fresh water. A sample of the water being analyzed for chlorides. This sampling down the drainage from the salt water ponds proved conclusively that all the ponds in the Equus Bed area allow the impounded brines to infiltrate downward into and pollute the shallow fresh water. The oil industry realizes that shallow disposal and surface brine ponds are not the answer to the disposal problem in this area and are cooperating with this department in a sincere effort to insure 100 per cent deep disposal.

Russell Area. Another field study embraced the oil area in Russell and Ellis counties. This survey was set up on a cooperative basis with the United States Geological Survey and the Kansas State Geological Survey. The factual data gathered in

this project will largely determine the brine disposal policy for the above area. This department has been concerned for some time as to the advisability of using the Cheyenne Sandstone as a disposal horizon for the following reasons: It is suspected that the shale member (Kiowa) which separates the Dakota waters from the Cheyenne waters is not of uniform thickness or persistent over the area. If this shale is not persistent, lenticular or shows a marked divergence, it would be a mistake to continue to the use of the Cheyenne sandstone as a brine disposal horizon and particularly so if injection pressure were necessary. The Cheyenne water is highly mineralized but some of the Dakota water can be used for stock purposes. It is therefore evident that with stock water often at a premium in the above section it becomes necessary to keep these two types of water from comingling.

COOPERATIVE STUDIES WITH THE UNITED STATES BUREAU OF MINES

For several years the State Board of Health and the United States Bureau of Mines have been working together under a cooperative agreement set up between the two agencies. From time to time the Bureau issues a report covering its findings on certain oil field studies. The most recent publication is R.I. 3573 "Use of Brine in a Kansas Field for the Secondary Recovery of Oil." This report can be supplied upon request.

A Bureau of Mines field party is now engaged in a disposal well survey in Kansas which should be of considerable value to the oil operator, as it will bring out treatment practices, disposal formations and other data pertinent to sub surface brine disposal systems.

The Bureau of Mines in order to conform to its established policy that it be only a fact finding agency, is not in a position to make definite recommendations following its findings. This department, however, may base its recommendations from the bureau's research studies.

MAJOR STREAM POLLUTION CASES

During the last few years there have not been a large number of stream pollution cases. Several salt water slugs have moved

down stream past municipal intakes but as they were of short duration, no serious damage resulted. Also, several pipe line breaks were reported, but in most cases the oil was trapped and burned before any considerable loss of fish life was reported. Only once during the last few years has this department resorted to the courts as a means of correcting pollution of a stream.

CASING PROGRAMS FOR DISPOSAL WELLS

In view of the fact that disposal wells oftentimes require pressure for the injection of the brine it is very important that the casing program for such wells be set up so as to maintain adequate protection to the fresh waters. This department has, therefore, been concerned on just how these disposal wells were cased. Aside from the injection pressure feature the brines are often so highly mineralized that it is not practical to expect steel casing to withstand for any considerable time, the corrosive action of these waters. It has, therefore, become the practice of most companies to use non-corrosive tubing in the disposal well after cementing a larger diameter pipe at the top of the disposal formation. This allows reconditioning of the disposal formation should the pore space become clogged with sediment.

As non-corrosive pipe is approximately the same price as ordinary line pipe, most of the gathering lines for disposal wells are now of this material. This does away of frequent gathering line replacement and consequent salt water leaks on or below the ground surface.

FURTHERING COMMUNITY DISPOSAL PROJECTS

One of the special services this department renders is aiding in the establishment of community disposal projects. Quite often several operators can use one disposal well and pro-rate the cost, thereby, saving considerable expense. Likewise it is often possible to put the produced brine from 50 or more oil wells into one deep disposal well.

On several instances it has come about that a disposal association was formed during a meeting of operators called by this department. Geological and technical information is given freely to the smaller companies not having technical staffs.

The oil industry is now much more brine disposal minded than at any time since the Oil Field Section was set up.

WATER FLOOD PROJECTS

This department has been active in disseminating information relative to the use of salt water as the repressuring agent in the secondary recovery of oil. What to do with produced brine in the older producing areas of southeastern Kansas has for years constituted a perplexing problem. In view of the fact that fresh water supplies are inadequate in that portion of the state it makes an ideal situation for the use of salt water long looked upon as a waste product. Salt water is a form of reservoir energy and it should be recognized as such. Water flood or augmenting the water drive by repressuring with salt water offers a real use for that type of water. The primary purpose of secondary recovery is to increase the ultimate yield.

This department has been consulted repeatedly by the small operator or groups of them upon input well patterns, porosity and permeability data and other information that the staff has or has access to in various areas.

BOTTOM HOLE CEMENTING

In an effort to limit the amount of water produced with the oil, the department is urging the technical staffs of several companies to study bottom hole cementing as a means of limiting water production and at the same time not impinge on the oil production. Careful bottom hole completions can do much to hold back excessive salt water production.

RECOMMENDATIONS TO ABANDON SMALL OIL PRODUCERS WHICH HAVE AN EXCESSIVE OIL WATER RATIO

In an effort to curb excessive water production this department often recommends as a water conservation measure, the abandonment of small oil producers provided these wells carry an excessive oil water ratio. When wells produce 500 barrels of water to 5 barrels of oil, the lifting costs on that amount of fluid are hardly justified, and what to do with such large amounts of brine presents an expensive problem when compared to the revenue derived from a small oil producer. Many operators to relieve themselves of handling such volumes of water as compared to the oil produced are voluntarily plugging that type of well. One company in the Burrton pool reduced its water pro-

duction by 75 per cent by plugging some of the Hunton lime wells. The Hunton lime is a prolific water producer.

STATE SERVICE WORK

Aside from regular duties the department is often called upon for work of a special nature. One member of the department was loaned to the Governor to head the drought emergency programs of 1934-36 and 1939. He also served on the Governor's Water Committee set up to formulate a state water plan. Both Doctor Helm of the State Board, and Chancellor Malott of the University, looked upon this special work as a desirable type of state service.

EDUCATIONAL PROGRAM

Carried along with the regular work of this section is what may be termed an educational program, which takes up the following points:

1. To convince the oil industry of the importance of protecting the fresh waters in the areas in which they are operating and to point out their responsibility in that protection.

2. To advise city officials of the necessity of taking an active interest in just how oil operations are carried on in the drainage area which embraces the water supply of their particular municipality.

3. Landowners are advised that it is not a wise policy on their part to allow the construction of deep disposal ponds in the state's porous soil areas.

4. Landowners are urged to welcome deep disposal wells and not to offer objections if a company wishes to inject other brines into the wells which are produced on other properties.

5. The oil operators are urged to speed up repair in pipe line breaks and the holding of the escaped oil from surface drainage. Also, the burning of oil spills and accumulated waste oil is recommended. Good lease housekeeping is desirable and profitable to the operator.

As a means of expediting sub surface disposal of oil field brines, the 1941 Legislature passed the following bill:

SENATE BILL NO. 340

By Senator Jones of Reno

AN ACT relating to certain corporations, granting the right of eminent domain to such corporations for the purpose of providing for the disposal of

oil-field or gas field brines and mineralized waters, and prescribing other powers of such corporations.

Be it enacted by the Legislature of the State of Kansas:

Section 1. Each company or corporation engaged in the production of petroleum or natural gas in Kansas, or organized for the purpose of providing for disposal of oil-field or gas field brines and mineralized waters, may own, lease, construct, operate and maintain pipe lines, reservoirs, treatment plants, disposal wells, and other facilities for the conveyance and disposal of such brines and mineralized waters, and shall be authorized to exercise the right of eminent domain as provided in section 26-101 of the General Statutes of 1935, and 26-102 of the General Statutes Supplement of 1939, and any amendments thereto, in acquiring the necessary rights of way, but not sites for the disposal of such brines and mineralized waters.

Sec. 2. That any person, company or corporation engaged in the production of petroleum or natural gas in Kansas, or in the disposition of oil field or gas field brines and mineralized waters, may provide for financing and acquiring the necessary land, easements, and rights of way, and may own, lease, construct, operate and maintain the works necessary for such disposal: PROVIDED, That the disposal of oil field or gas field brines and mineralized waters, the plans and specifications for such disposal works shall first be submitted to and be approved by the state corporation commission, and the state board of health. The state corporation commission, in giving its approval, shall determine that the proposed method of disposal will not result in the loss or waste of gas or petroleum resources. The state board of health, in giving its approval, shall determine that the proposed method is a feasible method to be employed in protecting the water resources of the state from preventable pollution.

Sec. 3. This act shall take effect and be in force from and after its publication in the statute book.

GROUND-WATER MOVEMENT

A given body of ground-water seldom is static or at rest. It can be assumed that ground water, especially the ground-water associated with defined drainage basins, is constantly moving, the movement usually being in the general direction of the surface drainage. The rate of movement is but a fraction of that of surface streams and generally is considerably less than 10 feet per day. The rate of ground-water movement depends upon the slope or gradient of its floor or upon the differential in pressures, the porosity and permeability of the aquifer.

In steep, narrow valleys, ground-water travels toward the stream channel, while in the lower reaches of major streams, the movement is approximately parallel to the stream channel.

Ground-water movement is mentioned in order to show how

contaminated water is carried from point of occurrence to distant points.

WHAT IS A BRINE

Oil field brines differ as to concentration in various fields, but in the main calcium, sodium and magnesium chlorides predominate in all analyses. Below is a tabulation in which a brine is compared to some other waters:

COMPOSITION OF MISCELLANEOUS WATERS

	River Water			Kansas City Lime-Brine	Sea Water	U. S. Public Health Service Drinking Water Stand.
	Kaw (Lawrence)	Neosho (Iola)	Verdigris (Coffey- ville)			
Calcium	89	83	56	9,000	353	100 (maximum)
Magnesium	21	24	13	4,290	1,945	
Sodium	52	46	62	63,275	11,500	250 (maximum)
Carbonate	10	0	0	—	—	
Bicarbonate	300	200	164	94		250 (maximum)
Sulphate	77	116	16	—	2,614	250 (maximum)
Chloride	54	83	124	127,220	19,488	
Nitrate	3	4.4	2.2	—		
Silica	17	23	17	—		
Total Solids	490	539	410	248,000	35,000	1,000 (maximum)

NOTE: Figures denote parts per million.

The following tabulation shows brines which are typical of several producing formations and areas in Kansas:

Radical	Field Chase	Center Valley	Center Valley	Canton Ritz	Bend Rainbow
Calcium	1,193	1,507	9,800	4,420	12,888
Magnesium	346	428	4,290	2,230	2,510
Sodium	8,260	15,200	63,275	9,230	55,780
Bromide	32	48	633	—	376
Carbonate	0	0	0	0	0
Bicarbonate	644	339	94	156	43
Sulphate	1,578	966	0	10	457
Chloride	12,750	22,080	127,220	28,600	115,580
Total Solids	25,210	44,820	248,600	52,640	210,550
Formation	Silicious	Simpson	Kansas City Lime	Viola Lime	Bartlesville (Burbank)
Depth	3,250'	3,375'	2,600'	3,350'	3,200'

NOTE: Radicals are expressed in parts per million.

These salts are inert both chemically and biologically, but due to the high concentration of mineral salts the practice of

allowing this waste to reach the streams presents a grave hazard to municipal water supplies. The complete chemical analyses often brings to light smaller amounts of such rare salts as iodides, bromides, and barium. War industries are interested in the Magnesium content of certain brines. The total solids in column three of the above tabulation shows 248,600 parts per million which means approximately two pounds per gallon. The pollutional effect of these highly mineralized waters becomes more apparent when they are compared with the drinking water standards set by the United States Public Health Service. Column No. 3 shows 248 times the total solids allowed in the above standard. In the Ritz Canton field alone, some 400 tons of salt are handled in the production of one day's oil run. A few fields are listed below giving the brine produced per day.

BRINE PRODUCTION—A PARTIAL LIST BY FIELDS

<i>Field</i>	<i>County</i>	<i>Producing Formation</i>	<i>Brine Barrels per day</i>
Chase	Rice	Silicious	11,500
Geneseo	Rice	Silicious	1,115
Heiken	Ellsworth	Silicious	1,700
Lorraine	Ellsworth	Silicious	2,600
Raymond	Rice	Kansas City	6,000
		Silicious	
Stoltenberg	Ellsworth	Silicious	5,130
Stratman	Ellsworth	Silicious	4,600
Welch	Rice	Chat	4,100
			<hr/> 36,745

It would necessitate 3,674,500 barrels of fresh water to dilute the 36,745 barrels of brine to a point where the resulting water would be acceptable for domestic use. The above result is based on the conservative assumption that each barrel of brine would pollute 100 barrels of fresh water. Providing a tabulation of the state's entire salt water production were possible to obtain, the figures would be overwhelming.

SUMMARY

The oil operator can perform his share in water conservation by allowing no salt water to escape from his leases into the surface drainage or to infiltrate downward into shallow fresh water beds by the use of earthen storage in areas having sandy, porous

soils. The oil industry can likewise be an aid in water conservation by adopting proper well spacing, which would sharply limit the excessive number of wells and consequently limit salt water production and encroachment. The modern petroleum engineer can serve his company and the water resources likewise by insisting upon up to date production practices.

New fields in the course of development should carry disposal costs along as a legitimate part of the production costs. Operating budgets in the older fields should be expanded so as to include adequate disposal projects.

The Conservation Division of the Corporation Commission is doing a creditable job in the plugging of abandoned wells. This same agency can also insist upon casing programs so designed as to allow no opportunity for salt water migration into fresh water beds. The same care should be exercised on the casing program for the injection well on disposal projects.

For the protection of his own and his neighbors fresh water, the landowner should insist that all produced brines be handled in such a manner as to offer no opportunity for pollution.

Municipalities in the drainage basins in which are also located oil fields should take a keener interest than heretofore evidenced as to just how effectively salt water disposal is accomplished in their particular drainage basin.

Inadequate supplies of potable water can quite conceivably be the limiting factor in the state's economic growth and as such must be protected from all abatable pollution not only from oil field brines, but other industrial wastes as well. With your continued help and understanding we may expect more progress toward the removal of the many hazards confronting the fresh water resources of these midcontinent oil states.

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